

Intracluster Light from Merger Simulations

Zarija Lukic

Paul Ricker

University of Illinois

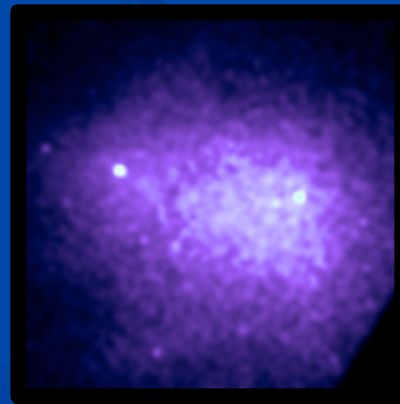
2nd Cosmology Day @ Lanl

Outline

- Clusters in general (properties)
- Importance of ICL
- Connection with BCGs
- Our simulations
- Conclusion

Clusters

- Biggest virialized objects
- Dark matter $\sim 80\%$ by mass
- Hot IC gas $T \sim 10^7$ K ; $\sim 20\%$ by mass
- Galaxies $\sim 1\%$ of the overall mass



Coma cluster

Importance of the ICL

- Clear detection (e.g. Durrell et al 2002; Feldmeier et al 2002)
- Contribution to cluster baryon fraction:

mean baryon fraction from clusters:

$$\Omega_B = 0.1441 \rightarrow \Omega_M = 0.32 \text{ (Mohr et al 1999)}$$

when include IC stars:

$$\Omega_M = 0.29 \text{ (Lin et al 2004)} \quad / \text{WMAP: } \Omega_M = 0.27 \pm 0.04 /$$

- Enrichment of IC medium

ICM contains huge amount of metals

(e.g. Baumgartner 2003)

stellar evolution in galaxies + transport - inefficient

(e.g. Portinari et al. 2004)

BCGs

- Bright Central Galaxies:

$$R_e \sim 20 \text{kPc}$$

$$M_* \sim 10^{12} M_{\text{sun}}$$

$$L \sim 5-10 L_*$$

very close to cluster's X-ray center

sit at cluster's rest frame

- 3 models for their formation:

galactic cannibalism

cooling flow

during initial collapse



Our Simulation - Setup

- We use FLASH code (Fruxell et al 2000)
- Mergers of clusters
- Cluster: DM - particles, PM method,

NFW:

$$\rho(r) = \frac{\delta_c \rho_{crit}}{r/r_s (1 + r/r_s)^2}$$

gas - Euler eq. PPM method,

beta model:

$$\rho_g(r) = \frac{\rho_{g,o}}{[1 + (r/r_c)^2]^{3\beta/2}}$$

- BCG: stars only (particles)

Hernquist model:

$$\rho_*(r) = \frac{M_*}{2\pi} \frac{a}{r(r+a)^3}$$

Our Simulation - Setup

- Everything in equilibrium initially:

gas:

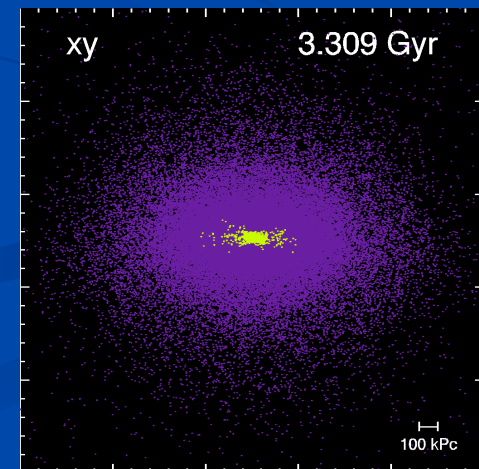
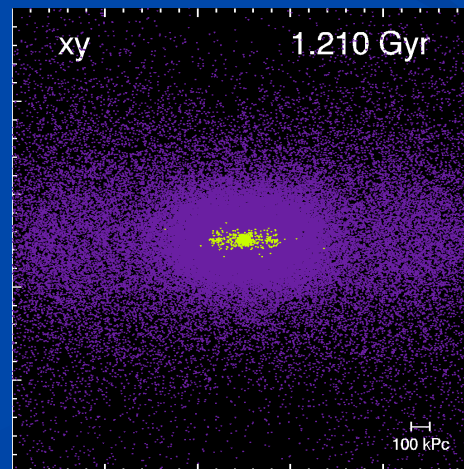
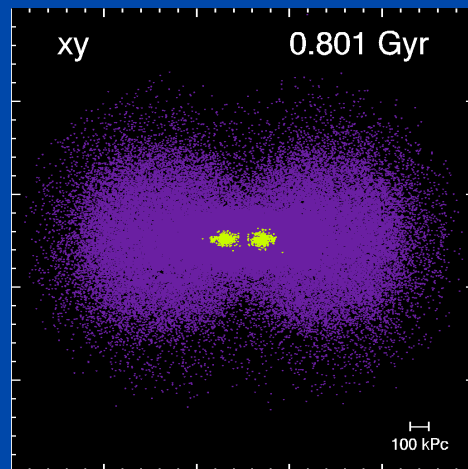
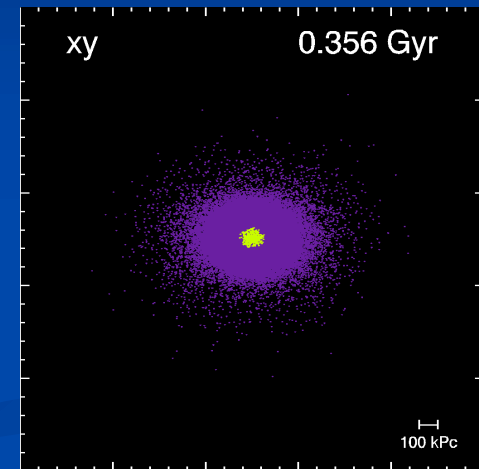
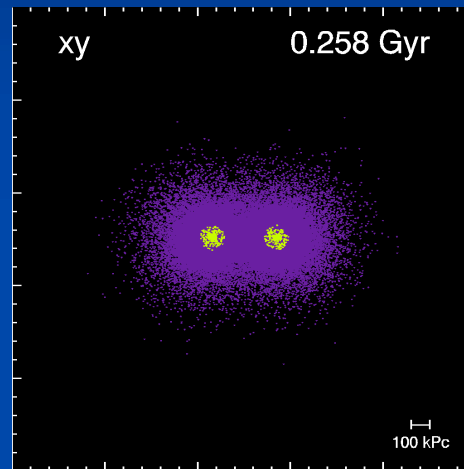
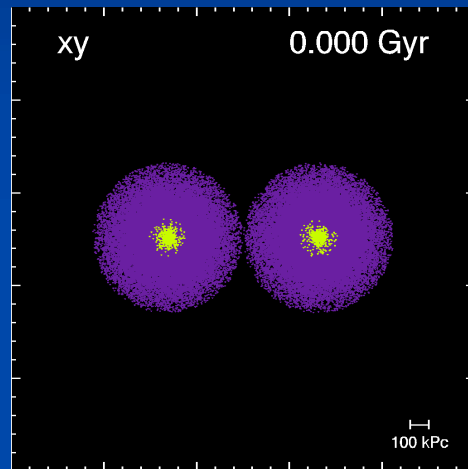
$$\frac{d}{dr} \left[\frac{\rho_g(r) k T(r)}{\mu m_H} \right] = - \frac{GM(r)}{r^2} \rho_g(r)$$

particles:

$$\frac{d}{dr} [\rho_p(r) \sigma^2(r)] = - \frac{GM(r)}{r^2} \rho_p$$

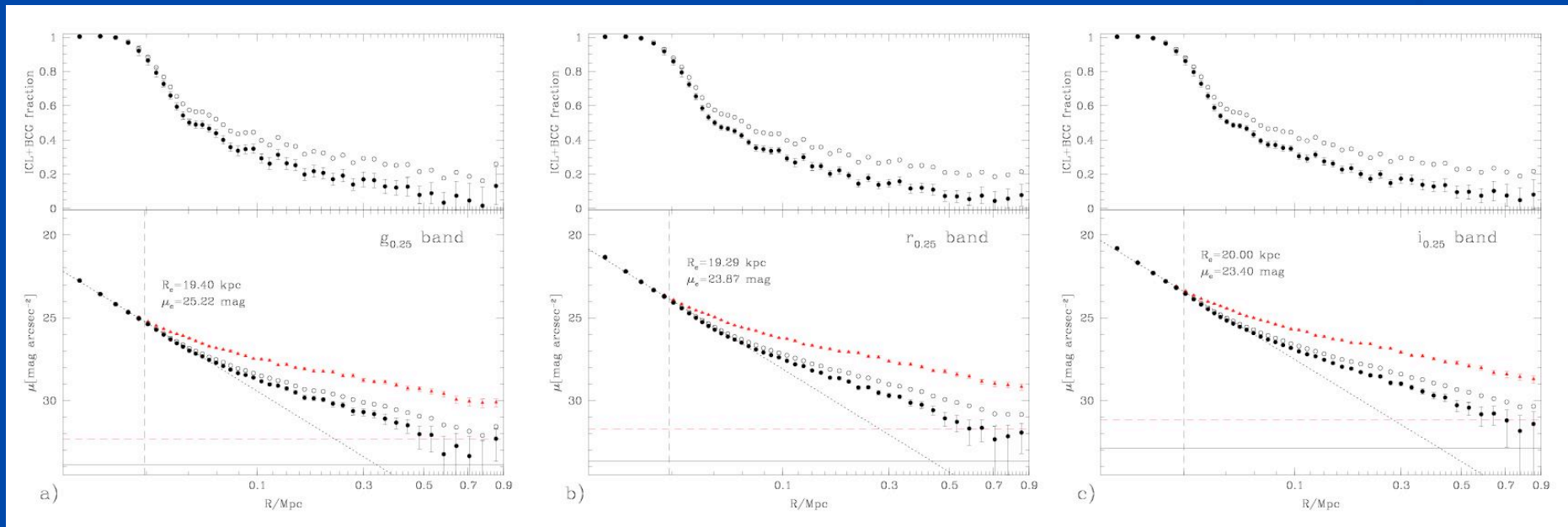
- To be finished:
 - star evolution models
 - other galaxies

Simulation



Check for

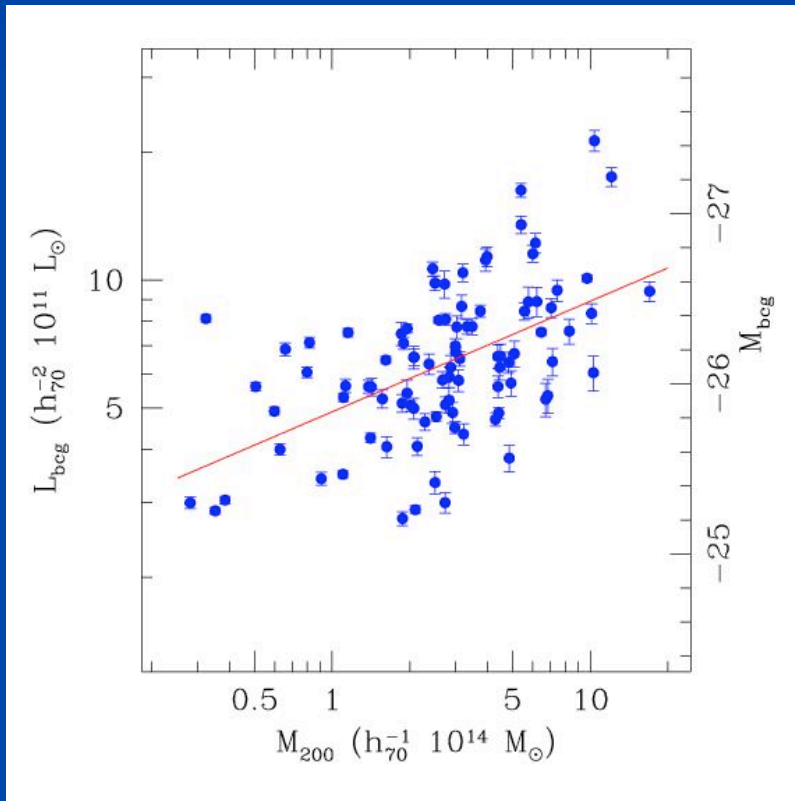
- Light curve from cluster (deviations from de Vaucouleurs law) ?



Zibetti et al. 2005

Check for

- BCG light to cluster mass correlation

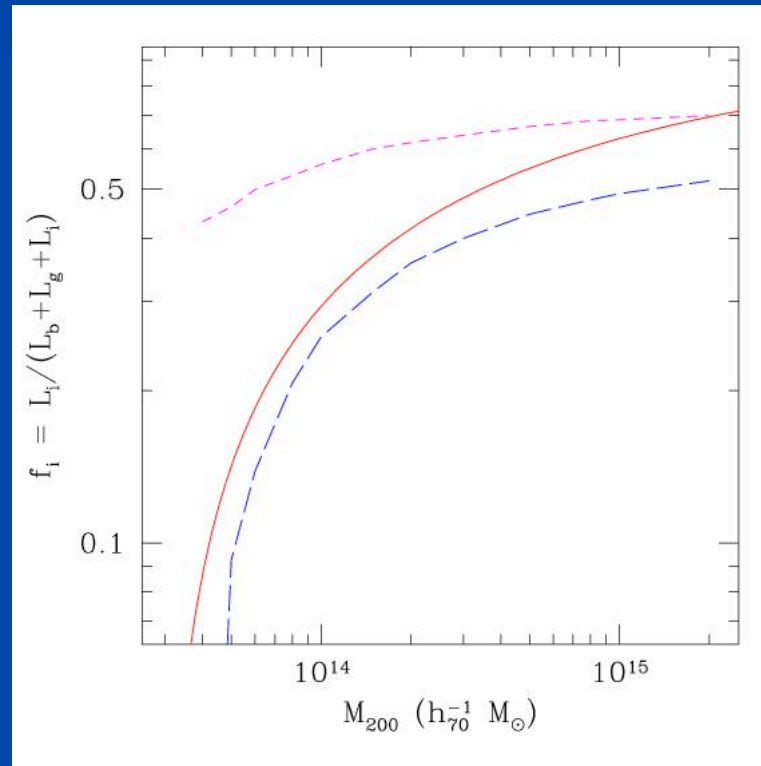


$$\frac{L_{bcg}}{10^{11} h_{70}^{-2} L_{sun}} = 4.9 \pm 0.2 \left(\frac{M_{200}}{10^{14} h_{70}^{-1} M_{sun}} \right)^{0.26 \pm 0.04}$$

Lin & Mohr 2004

Check for

- How IC light scales with cluster mass ?



Lin & Mohr 2004

Conclusion

- ICL plays important role in clusters evolution
- Tightly connected with formation and evolution of BCGs
- A lot of observed data has to be explained